ON THE FISHES OF THE RECENT AND PLIOCENE LAKES OF THE WESTERN PART OF THE GREAT BASIN, AND OF THE IDAHO PLIOCENE LAKE.

BY E. D. COPE.

Preliminary Observations.

The numerous lakes of the northwestern part of the Great Basin present many points of interest to the geologist and biologist. The region which they occupy is one of comparatively recent geological disturbance, so that their topographical features may be regarded as of relatively modern origin. Their former greater extent and intercommunication in groups has been clearly pointed out by the geologists of the U. S. Survey of the Fortieth Parallel; and the species of fishes found in the pliocene and post-pliocene deposits of the adjacent regions have been shown by myself[1] to be nearly allied to those now living in the present lakes.

The geologists of the fortieth parallel have shown that a large part of the present Territory of Utah was, during late tertiary time, occupied by a large body of water, of which Salt Lake, Utah Lake and Sevier Lake are the present representatives. To this ancient sea they have given the name of Lake Bonneville. They have also shown that the existing lakes of the western region of Nevada were formerly united into an extensive body of water, to which they have given the name of Lake Lahontan. It included the existing Walker's, Carson, Humboldt, Pyramid and Winnemucca Lakes. It is exceedingly probable that it will be shown that a third lake existed in Oregon, north of the supposed northern boundary of Lake Lahontan, which is now represented by the Warner Lakes, Abert's Lake, Summer Lake and Silver Lake, and probably by Harney's and Malheur Lakes on the eastern side of the Oregon desert. As will be shown later, the larger species of fishes found in such of these lakes as contain them, are identical, and different from those of the lakes of the Bonneville series. One species, the *Catostomus tahoensis*, is common to this area and that of the true Lahontan Lakes (Tahoe and Pyramid), and this Oregon lake may have been continuous with that of Nevada, at a point some distance east of the mountains. Goose Lake, the Klamath Lakes, and doubtless Rhett and Clear Lakes,

[1] Proceedings American Philosophical Society, Nov. 1870 and Dec. 1877.

form another series, characterized by several points of resemblance in their fish faunæ. Whether they were connected, forming a single body, at an earlier geological period, is not yet known. Some of them are connected by rivers and creeks at the present time, and the Klamath River discharges the contents of the lakes of the same name into the Pacific Ocean.

Still another late tertiary lake existed in Eastern Oregon and Western and Southern Idaho. No body of water represents it at the present time, and the remains of fishes found in its sediments belong to species different from those of the Oregon basin, both recent and extinct. It is to be supposed that this lake was separate from all of the others, and of earlier age, although one of the pliocene series. It may be called Lake Idaho, and its sediment, the Idaho formation. A list of its species will be given after the consideration of the characters of the faunæ of the Lahontan and Klamath Lakes.

The cause of the desiccation of the Great Basin and other interior regions of our continent, has not been satisfactorily explained. It is usually ascribed to the intervention of the Sierra Nevada and Rocky Mountain ranges, which precipitate the clouds from the Pacific Ocean, and thus deprive the regions eastward of rain. This would at first appear to be a sufficient explanation, but the facts of geological history contradict it. The existence of extensive lakes throughout the now dry region, in pliocene and postpliocene time, has been already referred to. But the Sierra Nevada was no less elevated then than now. Furthermore, great lakes or seas occupied the centre of the continent during miocene time, when the ranges were still higher. Vast forests of vegetation, and a rich population of animal life, point to a humid climate during the entire period that has elapsed since the great elevation of the Rocky Mountains in the beginning of the eocene epoch, to within comparatively recent times. Yet the mountains have been steadily diminishing by erosion throughout that period.

Of course the comparatively low elevation of the Great Basin would accelerate its desiccation, other conditions being equal. Mr. J. D. Clayton,[1] of Salt Lake City, discovered immense faults along the western slope of the Wasatch Mountains, and proposed the hypothesis that the entire area of the Great Basin had de-

[1] Published, I believe, in a number of the Salt Lake *Herald*, which I cannot at present lay my hands on.

scended several thousand feet during tertiary times. Mr. C. King[1] states that the fault along the eastern edge of the basin amounts to 30,000 feet, and that along the western border, from 3000 to 10,000 feet. The elevation of Pyramid Lake above the sea level is now, according to King,[2] 3890 feet. That of the Great Salt Lake is, according to Emmons, 4200 feet.[3] The depression, according to King, took place on the eastern side during early eocene times, and may have been nearly simultaneous on the western border. As a consequence of it, the Manti and Amyzon beds were deposited, representing the eocene period west of the Wasatch Mountains.

I. The Lahontan and Klamath Lakes.

The lakes of the Great Basin in Nevada and Oregon diminish in alkalinity as we approach the Sierra Nevada Mountains. While desiccation has concentrated the salts in all of them, those near the mountains have been maintained in a more or less fresh condition by the constant influx of the pure water of the mountain streams. The lakes most remote from the mountains are not habitable by fishes, their only animal population being crustacea and the larvæ of insects. Such are Summer and Christmas Lakes of Oregon; and the Malheur and Harney Lakes are said to have the same character. That of Pyramid Lake, although receiving the fresh waters of the Truckee River, is too alkaline to be potable. The following analysis is given in Mr. King's II Vol. of the Survey of the 40th Parallel (p. 824), as made by Prof. O. D. Allen, of Yale College:

Magnesia,	0·1292
Sodium,	0·8999
Soda,	0·4234
Chlorine,	1·3870
Sulphuric Acid,	0·1400
Carbonate of Lime,	0·0178
Carbonic Acid,	0·2392
	3·2365

in 1000 parts of the water.

[1] Survey of the 40th Parallel, i, p. 744.

[2] Loc. cit., iii, p. 822.

[3] Loc. cit., ii, p. 466.

The water of the Upper Klamath Lake is slightly alkaline to the taste, and less so than that of Pyramid Lake. The waters of Goose and Silver Lakes are similar to it, while that of Warner's Lake is rather more alkaline. All of these lakes abound in fishes. Summer Lake, Christmas Lake, and others, are intensely alkaline to the taste.

The locality which has furnished the greatest number of fossil remains of the pliocene or postpliocene ages, is known as Fossil Lake. It is twenty miles east of Silver Lake, in the western part of the Oregon Desert. It is a shallow depression of perhaps a hundred acres in extent, where drinkable water may be obtained by digging. The soil is a mixture of sand and clay, which supports a more or less luxuriant growth of Artemisia. Bones of extinct and recent species of vertebrata, thoroughly fossilized, mixed with worked flints,[1] and shells of *Carinifex newberryi* bleached snow-white, lie in profusion in this light material. Within a short distance of this locality the soil becomes sandy, and a few miles northeastward the surface of the country consists of sand-dunes, which rise to a height of one hundred feet. The sand is constantly moving to the northeast under the influence of the prevailing southwest wind, creeping up the long southwest slope of the dunes, and falling in a fine shower over the apex of the vertical northeast face. This tract is perhaps twenty miles in diameter.[2] A smaller tract of a similar character lies at the northern end of Summer Lake, where the sand is piled up against the basaltic hills that bound its valley on the east. I have given lists of the vertebrate fossils of this region, as cited in the accompanying foot-notes.

As described by Emmons,[3] Pyramid Lake is thirty miles long, by twelve wide. It is surrounded by mountains of eruptive granite, trachyte and basalt. According to King, the level of this lake rose, between 1867 and 1871, nine feet, while that of the connected lake, Winnemucca, rose twenty-two feet. This lake is exceedingly rich in life, as will be pointed out by and by. Messrs. Jordan and Bean[4] have catalogued several species of fishes as

[1] See *American Naturalist*, 1878, p. 125.

[2] See Bulletin of the U. S. Geol. Survey of the Territories, F. V. Hayden, iv, p. 389; v, p. 48.

[3] Survey of the 40th Parallel, i, p. 506.

[4] Rept. of the Chief of Engineers, U. S. A. Expl. and Surv. W. of 100th Mer., G. M. Wheeler, 8vo, 1878, p. 187.

found in it, and I enumerate several additional ones in the present article.

The Mud Lakes in the neighborhood south of Fort Bidwell lie in a monoclinal valley of moderately inclined beds of a plutonic outflow. The strata dip towards the Sierra Nevadas, westwards. A high divide on the north separates these lake basins from that of the Warner Lakes. As already remarked, it is possible that they may have been connected by water, which occupied lower lands to the eastward, but this point remains as yet unsolved.

The four Warner Lakes occupy a long valley, which trends north and south. They are connected by a stream which flows through a succession of swamps of *Typha latifolia.* They abound in fishes and fishing-birds. The valley is apparently a fractured anticlinal, the strata dipping away from the lake on both the east and the west sides. The rocks are a dark-colored basalt. At the first and second lakes the western bluff is the higher, reaching, to judge by the eye, nearly a thousand feet elevation at the lower part of the third lake. At the northern part of the latter, at Wilson's Ranch, the eastern bluff is the higher, reaching the grand proportions of two thousand feet, estimated measurement.

Summer Lake is eighteen miles long and six or seven miles wide. The hills and bluffs of the western side probably reach a thousand feet in elevation. Those of the eastern side are much less elevated, and are separated from the water by a wide slope of sand and alkaline earth and mud. The western range is basaltic. At one point where the escarpment is especially steep, the brown basalt is overlaid by a deposit of white pumice or siliceous dust, which is worn into a picturesque sculpture by the weather.

I did not get a near view of Abert Lake, but it lies between high basaltic bluffs, of which the eastern is the more elevated, rising to a great height above the water. It is supplied with water by the Chewaucan River, which is a large creek with a fine flow of pure water. It abounds in fishes, especially the trout, *Salmo purpuratus.*

Silver Lake also lies in a valley with eastern and western walls of basalt. The strata of which the walls are composed, dip away from each other here, as at Warner's Lake, producing the impression that the lake occupies a fracture in an anticlinal. A range of hills, terminating at its eastern extremity in a bluff, extends along

the north side of the lake. The rock of which it is composed differs from those of the principal ranges, in being a finely bedded volcanic conglomerate mud. The same material forms bluffs forty-five miles eastward in the desert. During the season of 1882 the waters of Silver Lake rose higher than had been previously known. It is probable that these lakes are rising, as is the case with Pyramid Lake. A comparatively small elevation would connect the waters of Silver Lake with Summer Lake, eighteen miles distant, and those of Summer Lake with the Chewaucan River, seven miles distant. This would convert the Chewaucan Swamp into a lake, and connect the Abert Lake with the series.

Goose Lake is thirty miles in length and about ten miles in width. It is bounded on the east and west by eruptive mountains of no great elevation near the lake, but which rise gradually to a considerable height, especially to the eastward. To the north and south the valley of the lake continues for several miles. It is cut off to the north by the watershed of the Chewaucan, and to the south by that of Pitt River. The scenery of its banks is tame as compared with that of some of the other lakes, but presents nevertheless many elements of beauty. It is shallow for a long distance from its northern and eastern shores. It abounds in fishes and water-birds. I fished for a day with hook and line without success, but procured a good collection of fishes by another method. I found numerous specimens both fresh and dry, which had been dropped by fishing-birds on or near the shore.

The great or Upper Klamath Lake is thirty-two miles long, and of irregular width, and is said to be twelve miles across its widest part. Its western shore is the base of the Cascade Mountains, and its eastern shore is bordered by a low range of eruptive hills. Both shores are wooded; and the scenery, though it lacks the rugged grandeur of that of Warner's and Abert's Lakes, is highly picturesque. The symmetrical proportions of Mount Pitt are ever visible on its eastern shore, while the more central peaks of the Cascades are in view from its northern extremity. It is fed by several streams, the most important of which is the Williamson's River, which enters it from the east. This has a considerable flow of water. The Link River, which connects the Upper and Lower Klamath Lakes with the Klamath River, is a wide and rapid stream containing much water.

The Upper Klamath Lake is more prolific in animal life than any body of water known to me. The proportion of alkali which it contains appears most favorable to the development of life. Its waters are full of vegetable impurities, living and dead, and mollusca and crustacea abound everywhere. These sustain a great population of fishes, which, though not numerous in species, is so in individuals. Swarms of fishing-birds employ themselves in catching them living from the lake. The most abundant mollusca are the *Planorbis* (*Carinifex*) *newberryi* Lea, and a *Lymnæa*. A probably hydroid polyp is found attached to the bark of submerged trees in large numbers. Its creeping yellowish stems are imbedded in sarcode, forming a continuous mass. Each zoöid is of an elongate oval form, sessile, and with six rays of equal size, each one-half as long as the body. These zoöids are translucent, but with two oval bodies in the lower half of the body-cavity, of a yellow color. The masses are as large as the fist. The length of each zoöid is one millimetre. They did not extend themselves beyond this length, neither did the rays elongate to beyond half the same, so long as I observed them. They retracted themselves on being irritated. They do not possess any fringes like the arms of the Polyzoa. As the possession of a cœnœcium distinguishes this genus from all the fresh-water hydroids, I propose to characterize this remarkable form as the type of a new genus, with the name of *Rhizohydra*, and the species, by the name of *flavitincta*.[1]

The following mollusca which I obtained were identified by Mr. Tryon, to whom my acknowledgments are due:—

Ancylus newberryi Lea.
Limnæa stagnalis Lea.
Physa gyrina Say.
Pompholyx effusa Lea.
Planorbis corpulentus Say.
Carinifex newberryi Lea.
Anodonta wahlamatensis Lea.

In my explorations of these lakes, I was greatly aided by Col. Whipple, in command at Fort Klamath, and Col. Barnard, in command at Fort Bidwell, and Dr. George Kober, surgeon at the

[1] My attempts to preserve some of the masses of this animal in alcohol were not successful.

latter post. To these gentlemen I wish to express my thanks. My especial thanks are also due to General W. T. Sherman, commander-in-chief of the army, from whom I have received many favors, on this and other occasions.

Synopsis of the Fishes.

ISOSPONDYLI.

Salmo purpuratus Pallas.

Pyramid Lake; Chewaucan River; Silver Creek (tributary of Silver Lake); Klamath Lake, and Williamson's River.

As Jordan remarks, this fish varies as to its color-shades, and is hence imagined by fishermen to include several species. A specimen from Link River (the part of Klamath River connecting the Klamath Lakes) is nearly silver-white. Specimens from Williamson's River are of darker color. I examined a large number of individuals from that stream, and found the following variations in some of them. One specimen Br. XI; Anal $10\frac{1}{1}$; one, Br. XII, A. $9\frac{1}{1}$; six, Br. XII, A. $10\frac{1}{1}$; three, Br. XIII, A. $10\frac{1}{1}$; one, Br. XIII, A. $11\frac{1}{1}$; one, Br. XIII, A. $12\frac{1}{1}$.

An important food fish, sometimes reaching ten pounds in Klamath Lake.

Salvelinus malma Walb.

Seven-mile Creek, which enters Lake Klamath from the northwest.

PLECTOSPONDYLI.

APOCOPE Cope.

Apocope ventricosa Cope. Jordan, l. c., p. 211.

Abundant in the small streams near Fort Bidwell, N. E. California.

Apocope vulnerata Cope. Jordan, l. c., p. 210.

Abundant in streams near Fort Bidwell, and in those tributary to Warner's Lake and Abert's Lake.

AGOSIA Gird.

This genus is stated by Jordan to agree with *Apocope*, excepting in the possession of a complete lateral line.

Agosia novemradiata Cope, sp. nov.

Scales 11–60–11; radii, dorsal I. 9; anal I. 7. The head is rather elongate, especially the muzzle, which projects a little beyond the mouth. Eye 4·5 times in length of head; 1·5 times in

length of muzzle, and in interorbital width. Head four times in length without caudal fin; depth at ventral fin, five times in the same. Dorsal fin originating behind line of last ventral ray; radii always I. 9. Caudal peduncle rather deep.

Measurements.	M.
Total length (with caudal fin),	·107
Length to edge of operculum,	·010
Length to first ventral ray (outside),	·044
Length to first dorsal ray (outside),	·047
Length to first anal ray (outside),	·060
Length to base of caudal fin,	·085
Depth at occipital region,	·013
Depth at first dorsal ray,	·018
Depth at first anal ray,	·016
Depth of caudal peduncle,	·009

Color silvery, dusted with smoky, to below the lateral line, and marked on the sides and back with several rows of dusky spots. Bases of inferior fins and upper lip red.

This species differs from the species of *Apocope*, which it generally resembles, in having a perfect lateral line. It agrees with the *A. henshavi* in having nine dorsal rays, but has a longer muzzle and larger scales. The latter has the following scale formula, 16–67–12. It is possible that some of the specimens referred by Jordan to the *A. henshavi* belong here. Abundant in Weber River at Echo, Utah.

CLIOLA Gird.

Hybopsis "Agass." Cope and others.

Cliola angustarca Cope. Proceeds. Amer. Philos. Society, 1877, p. 230.

Well distinguished from the allied fossil species by its narrower pharyngeal bones, and its teeth 4–4. Fossil Lake, Oregon.

MYLOLEUCUS Cope.

Annual Report U. S. Geol. Survey Terrs., 1871, p. 475. Jordan, Synopsis Fishes North America, 1883, p. 887.

This genus differs from *Leucus* Heck. in its dental formula, 5–4 instead of 5–5. It is characteristic of the streams and lakes of the Great Basin, and of those waters of Oregon and California which lie nearest to them. Most of the lakes of southwestern Oregon contain them, and their variations are such as to render their

specific characters somewhat difficult to unravel. Teeth of species of this genus occur in the pliocene lake deposits of the Great Basin.

Myloleucus gibbarcus Cope. *Alburnops gibbarcus* Cope, Proceeds. Amer. Philos. Society, 1877, p. 230. *Anchybopsis breviarcus* Cope, l. c., p. 229.

The presence of four teeth on the right pharyngeal bone of specimens referred to *Alburnops*, as above, is not established; and the other characters point to the specific identity of the individuals included under the two names cited. It was abundant in a fossil state at Fossil Lake, Oregon, whence I have obtained about twenty pharyngeal bones of both sides. First discovered by Chas. M. Sternberg.

The recent species may be distinguished as follows:—

Scales 11-12—51-5—6-7; anal rays I. 8; head 3·5; depth 3·5 to 4 times in length. *M. formosus.*

Scales 10—47-50—5; anal rays I. 8; head 3·5; depth 4 times in length. *M. parovanus.*

Scales 9–46–4; anal rays I. 9; head 3·75; depth 4·5 times in length. *M. thallassinus.*

Myloleucus formosus Girard. Jordan, Synopsis Fishes N.A., p. xxi. *Leucus formosus* Jordan, Report Capt. G. M. Wheeler, Expl. W. 100th Mer., 8vo, 1878, p. 193.

Specimens of this fish from Silver Lake represent a form of the species allied to the *M. obesus*, in the greater depth of the body than those found in the Chewaucan River and the Warner Lakes. In the first named, the depth enters the length 3·5 times; in the last two, four times. The Silver Lake specimens diverge from the types in having the scales a little larger. They are thus counted in the three sets of specimens:—

Silver Lake 11—51-3—8; Chewaucan 11–55-7; Warner Lake 12—54-5—7. The largest specimen is from Warner's Lake and measures 8½ inches in length.

Myloleucus parovanus Cope. Zoology Wheeler's Expl. Surv. W. 100th Mer., p. 669.

This species was originally described by me from the Beaver River of Utah. It now appears that is the most abundant cyprinoid of Goose and Klamath Lakes. It reaches a length of 10 to 12 inches, and forms a large part of the food of the great flocks of various species of fishing-birds which live at those lakes. Its specific characters are constant in a large number of individuals. Prof. Jordan identified this species with the *M. bicolor*

of Girard, but he gives the scale formula of that species as 8–50–5, and the anal rays as 7—characters quite inconsistent with the *M. parovanus*.

Myloleucus thalassinus sp. nov.

This species rests on a single specimen which I obtained at Goose Lake, Oregon. It is a more slender fish than the *M. parovanus*, and its color when fresh is light, translucent green, quite different from the more or less heavy olivaceous color of the latter. Its proportions are expressed in the key above given, as well as the smaller number of longitudinal rows of scales, and the additional ray of the anal fin.

Measurements.	M.
Total length (with caudal fin),	·143
Length to edge of opercle,	·031
Length to base of dorsal on lateral line,	·059
Length to base of ventral on lateral line,	·061
Length to base of anal on lateral line,	·0805
Length to base of caudal on lateral line,	·114
Depth at first dorsal ray,	·026
Depth at first anal ray,	·022
Depth of caudal peduncle,	·014
Width of interorbital region,	·010
Width of orbit,	·007

LEUCUS Heckel.

Fische Syriens, 1843, p. 48. *Anchybopsis* Cope, Proceed. Amer. Philos. Society, 1870, p. 543.

I found recent species of this genus in Pyramid Lake, Nevada, only. Some extinct species occur in the pliocene beds of Oregon and Idaho.[1] The two species from Pyramid Lake differ as follows:

Scales 13-14—56-9—7-8; anal rays I. 8; head 3·66 in length; depth 4 (3·75); eye in head 5 times. *L. olivaceus.*

Scales 14-15—63-6—8; anal rays I. 8; head 4 times in length; depth 4·5 times; eye 3·5 in head. *L. dimidiatus.*

[1] *Leucus latus; Anchybopsis latus* Cope, Proceeds. Amer. Philos. Soc., l. c., Idaho; size large. *Leucus altarcus; Anchybopsis altarcus* Cope, loc. cit., 1877, p. 229. From Oregon; small.

Leucus olivaceus sp. nov.

The largest cyprinoid of the Pyramid Lake, and very abundant. The shape is a regularly compressed fusiform. The head narrows to the muzzle, and the mouth opens obliquely forwards and upwards. The end of the maxillary bone, when the mouth is closed, is concealed in a sheath, and extends a little beyond the anterior margin of the eye. The latter enters the length of the muzzle (without the chin) 1·33 times; and the interorbital space 1·60 times. Middle of front a flat longitudinal surface, bounded on each side by an angle, from which the surface slopes to the superciliary border. In the *Myloleucus parovanus*, a fish of similar size, the frontal is flat roof-shaped, there being a median longitudinal angle. In specimens from Klamath Lake, however, the lateral angles are more distinct than in those from Goose Lake. This fish is everywhere a dusky olive, except on the belly, which is silvery. No lateral band. Fins dusky.

Measurements.	M.
Total length, with caudal fin,	·283
Length to edge of opercle,	·064
Length to base of dorsal, on lateral line,	·122
Length to base of ventral, on lateral line,	·131
Length to base of anal, on lateral line,	·173
Length to base of caudal, on lateral line,	·235
Depth at first dorsal ray,	·060
Depth at first anal ray,	·043
Depth at caudal peduncle,	·027
Width of interorbital region,	·020
Width of orbit,	·0126

This and the smaller *L. dimidiatus* swim in schools in the lake, and may be seen from the elevated road along the rocky shores, rippling the surface like a gust of wind. At this signal, the pelicans, gulls and terns quickly congregate, and are soon actively employed in fishing.

Leucus dimidiatus Cope. sp. nov.

This very abundant fish is much smaller than the adult *L. olivaceus*, and has a more slender form, smaller scales, and a different coloration. The eye nearly equals the interorbital width

and a little exceeds the length of the muzzle. The mouth slopes upwards, and the extremity of the maxillary bone reaches to the anterior edge of the orbit. The ventral fin originates behind the point below the first dorsal ray by the width of a ray. The fins are all rather small, except the caudal. The sides and belly are a pure silver-white up to the eighth row of scales below the dorsal fin. Above that line the sides and back are a light brown, becoming lead-colored along the border of the white. In some specimens this lead-color forms an obscure band.

Measurements.	M.
Total length with caudal fin,	·104
Length to edge of opercle,	·021
Length to first dorsal ray on lateral line,	·042
Length to first ventral ray on lateral line,	·043
Length to first anal ray on lateral line,	·060
Length to caudal fin on lateral line,	·084
Depth at first dorsal ray,	·019
Depth at first anal ray,	·0148
Depth at first caudal peduncle,	.009
Width of interorbital space,	·007
Width of orbit,	·006

This species exists in immense numbers in Pyramid Lake, where it doubtless furnishes much food for the trout, *Salmo purpuratus*.

Leucus altarcus Cope. *Anchybopsis altarcus* Cope, Proceeds. Amer. Philosoph. Soc., 1877, p. 229.

Extinct; from Fossil Lake, Oregon, only. Represented by pharyngeal bones and teeth.

SIPHATELES Cope.

Gen. Nov. Char.—Pharyngeal teeth 5–5, with well developed grinding surfaces. Ventral fins beneath the anterior part of the dorsal. Lateral line very imperfectly developed.

This genus is *Leucus*, with undeveloped lateral line. The only species does not resemble any of the others here described.

Siphateles vittatus sp. nov.

Scales 11–55–5; radii D. I. 8; A. I. 8. Head 4 times in length without caudal fin; depth of body 4·5 times in the same. Eye one-third of length of head, and a very little less than interorbital

width. Mouth opening obliquely upwards, the maxillary not quite reaching the anterior edge of the eye.

Measurements.	M.
Total length with caudal fin,	·077
Length to edge of operculum,	·016
Length to line of dorsal fin on lateral line,	·0323
Length to line of ventral fin on lateral line,	·0328
Length to line of anal fin on lateral line,	·045
Length to base of caudal on lateral line,	·061
Depth at first dorsal ray,	.0133
Depth at first anal ray,	·0105
Depth of caudal peduncle,	·0068
Diameter of interorbital space,	·045
Diameter of eye,	·0445

Belly and sides silvery; a straight lead-colored lateral band; above this, pale reddish (in spirits). The leaden band is interrupted at the base of the caudal fin by a vertical band of straw-yellow, which has a dark posterior edge.

In the species of *Leucus* from the same locality (Pyramid Lake), there are 23 or 24 longitudinal rows of scales; in this one there are only 17.

SQUALIUS Bonap.

Jordan, Synopsis Fishes N. America, p. 230.

The species of this genus, as defined by Jordan, that I have observed in the Oregon Lakes, are two, which differ as follows:

Scales 13–63–7; dorsal rays I. 9; head 3·75 to 4 times in length; depth in do. 4 times; eyes in head 4·25 times; teeth 2·5–5·2.

S. cæruleus.

Scales 12–60–5; dorsal rays I. 8; head 4 times in length; depth in do. 4·25 times; eye in head 3 times; teeth 1·4–5·1.

S. galtiæ.

Squalius cæruleus Girard. Jordan, l. c., p. 241.

Abundant in Klamath Lake. The specimens differ among themselves somewhat; thus, the depth enters the length 3·60 times in some; 4 times in others. The dorsal fin originates above the ventral in some; a little behind in others. The teeth all have the grinding surface distinct, and the dorsal fin always has I. 9 rays. Length of the longest specimen, $5\frac{1}{8}$ inches.

Squalius galtiæ sp. nov.

This species belongs to the group *Clinostomus*, where the dorsal fin originates a little behind the line of the front of the ventrals, and the teeth have no grinding surface. The lateral line is, on the other hand, but little decurved, and there are but eight anal rays (in one specimen nine). The muzzle is short and the mouth oblique, without prominent chin, and with the extremity of the maxillary bone extending a little beyond the line of the anterior rim of the orbit. The interorbital region is gently and regularly convex, and is as wide as the diameter of the orbit.

The color is olive above, as far laterally as a plumbeous band which extends from the superior angle of the operculum to the middle of the base of the caudal fin. Below this line, the sides and belly are silver, except a broad band of crimson, which extends from the branchial fissure, to the line of the first anal ray. Side of head with a dusky band. This is the only species I have seen in this region which displays brilliant colors.

Measurements.	M.
Total length with caudal fin,	·067
Length to edge of opercle,	·014
Length to first dorsal ray on side,	·0298
Length to first ventral ray on side,	·0282
Length to first anal ray on side,	·0385
Length to base of caudal fin,	·056
Depth at first dorsal ray,	·014
Depth at first anal ray,	·0103
Depth of caudal peduncle,	·006
Interorbital width,	·0043

This pretty species is quite abundant in Pyramid Lake.

CHASMISTES Jordan.

This curious genus is confined to the lakes of the Great Basin. One species, the *C. liorus* J. and G., is very abundant in the Utah Lake, while the others occur on the western side of the same zoölogical area. Two of them I discovered in Lake Klamath in 1879, and I now add a fourth from Pyramid Lake. These fishes are the largest that inhabit the waters of the Great Basin. They are essentially Catostomi in which the fleshy lips are wanting, the mouth having the characters of the majority of the Cyprinidæ.

Chasmistes cujus sp. nov.

I procured but one specimen of this fish from Pyramid Lake, where it is difficult to obtain. The size is large; the specimen I procured measured eighteen inches in length. The head is wide and flat, the width of the interorbital space being more than half the length. The upper lip is very thin; the lower lip is represented by folds on each side, which do not connect round the symphysis. Scales 13–65–11. Dorsal rays 12; anal I. 8. The eye enters the length of the head 8·5 times, and the interorbital width 4·5 times. The swim-bladder has but two cells. The colors are pale olive.

The pharyngeal teeth of this species are much like those of the *C. liorus* in their triangular section; they are, nevertheless, of delicate construction. The head of this species is relatively larger and wider than in any of the others, which gives it a heavy and clumsy appearance.

This fish is said by the fishermen to inhabit the deepest water, and to be seen in numbers only at the time of breeding. Its habits in this respect agree with what is said of the *C. luxatus* of the Klamath Lake. The Indian name of the *Chasmistes cujus* is "Couia."

Chasmistes brevirostris Cope. American Naturalist, 1879, p. 785. Jordan, Fishes N. Amer., p. 132, 1883.

This fish does not exceed 14 to 16 inches in length, and has a differently formed head and muzzle from the *C. luxatus*. They are shorter, especially the muzzle, and the latter is without the hump produced by the protuberant premaxillary spines. Parietal fontanelle small. The lower lip-fold is only present at the sides of the mandible. Both lips are smooth. Eye round, its diameter entering the length of the head six and two-thirds times, of which three times enters the muzzle. Interorbital region flat, its width entering the length of the head two and one-eighth times. Body nearly cylindric. Scales 12–74–11; radii D. 11, A. 9. Color dusky above, silvery below; fins colorless. This fish is abundant in Klamath Lake, but I was informed by a Klamath chief, that it does not ascend Williamson's River in spring with the *C. luxatus* and *Catostomus labiatus*. Klamath name, "Xoöptu."

Chasmistes luxatus Cope, American Naturalist, 1879, p. 785. Jordan, l. c., p. 132.

Form elongate; head long, flat above, and with a large fontanelle. Mouth terminal, the spines of the premaxillary bones projecting so as to form a hump on the top of the snout. Lower lip a very

thin dermal fold, extending entirely around the chin. Both upper and lower lips delicately tubercular. Eye oval, the axis longitudinal, and contained seven times in the length of the head, of which three and a-half times are contained in the muzzle. Interorbital region flat, one-third as wide as the head is long. Scales 12–80–9; radii D. 11, A. 9. Color clouded above with black punctulations; below paler, with red shades in some specimens; fins uncolored. It attains a length of nearly three feet. It ascends the streams tributary to Lake Klamath in thousands in the spring, and is taken and dried in great numbers by the Klamath and Modoc Indians. The former call it "Tswam."

The character of the lips, the oval eye, and the less interorbital width distinguish this species from the *C. brevirostris*, as well as the longer muzzle and superior size adduced in my original description.

On this species and the *C. brevirostris* I proposed the genus *Lipomyzon*, on the supposition that the pharyngeal bones and teeth of *C. liorus* were like those of the genus *Catostomus*, from which those of these species differ in their greater attenuation. During the summer of 1882, I obtained a number of specimens of *C. liorus*, and find that while its pharyngeal bones are less attenuated than those of *C. luxatus*, they are more so than in some species of *Catostomus*, so that I cannot distinguish, generically, the species of Klamath Lake. The pharyngeals of *C. brevirostris* are not more attenuated than those of *C. liorus*.

CATOSTOMUS Les.

Catostomus labiatus Ayres. Cope, American Naturalist, 1879, p. 785.

This species abounds in Klamath and Goose Lakes, but I did not observe it in any of the lakes to the eastward of these. The formulæ are:—

Klamath Lake: scales, 10–74–11; radii D. I. 11; V.10; head 4·5 times in length; eye 5·5 times in head.

Goose Lake: scales 12-13—75—11; radii; D. I. 11; V. 10; eye 6; head 4·5 times in length.

The largest specimens measure twelve inches in length. Remains of species of this family are abundant in the pliocene sands of Oregon, but do not represent many species. Pharyngeal bones and teeth indicate that the species are true Catostomi.

Crania and other bones of one of the species have been found abundantly at Fossil Lake. In some of the specimens the

pharyngeal bones and teeth are preserved. I cannot distinguish the specimens from corresponding parts of the common sucker of Lake Klamath, named by Ayres as above. They, however, present considerable variations among themselves. These may be stated as follows :

I. Ethmoid and front convex transversely.
   a. Parietal fontanelle small. Two specimens.
   aa. Parietal fontanelle large. Three specimens ; two of them lent me by Prof. Thos. Condon, of Eugene, Or.
II. Ethmoid and front a little convex ; fontanelle large ; in both points resembling the typical specimens from Lake Klamath. One specimen.
III. Ethmoid and front plane, the latter a little concave in profile. Fontanelle large. One specimen.

There are numerous other skulls in my collection, but they are not yet sufficiently cleared of matrix to display their characters.

Catostomus batrachops sp. nov.

This sucker is characterized by the short, wide and depressed form of the cranium. The ethmoid bone is considerably more than twice as wide as long (minus the spine), while in *C. labiatus* it is only half as long as wide. The interorbital width is equal to the length of the skull, minus the ethmoid bone and epiotic spine ; in *C. labiatus* this width is a good deal less than the dimension mentioned. The ethmoid and frontal bones are less convex than is the case in the more common fossil variety of *C. labiatus.* Although the bridge separating the temporal and pterotic fossæ is wide in *C. labiatus*, it is wider in the *C. batrachops*, and has a concave superior surface, which is not separated by ridge or angle from that of the superior plate of the parietal bone. There is no frontal keel, and the fontanelle is well developed.

Measurements.	M.
Length from epiotic spine to ethmoid spine, inclus.,	·084
Length of ethmoid, minus spine, ...	·018
Length of frontal bone (median), ...	·032
Length of parietal bone (median), . . .	·015
Interorbital width, ...	·056
Width at pterotics, about	·062
Width between apices of epiotics, . . .	·032
Width of ethmoid, ...	·042

This species appears to have been about eighteen inches in length. The only skull which represents it was found by Charles H. Sternberg, near Silver Lake, Oregon.

Catostomus tahoensis Gill and Jordan. Synopsis Fishes N. Amer., 127.

This is the common species of the lakes which represent the Lahontan Basin. I found it in Pyramid Lake and the third Warner Lake. The formulæ are as follows:

Pyramid Lake: scales 14–89–14; radii D. I. 11; V. 9; head 4·5 times in length.

Warner Lake: scales 16–83–15; radii D. I. 11; V. 9; head 4 times in length.

PERCOMORPHI.

URANIDEA Dekay.

Uranidea minuta Pallas. Jordan Synopsis, p. 698.

Abundant in Klamath Lake; not seen elsewhere.

General Remarks.

The species noticed in the preceding pages may be enumerated with reference to their geographical distribution, in the following lists:—

I. Pyramid Lake.

Salmo purpuratus henshavi Jord.
Leucus olivaceus Cope.
Leucus dimidiatus Cope.
Siphateles lineatus Cope.
Squalius galtiæ Cope.
Chasmistes cujus Cope.
Catostomus tahoensis G. & J.

II. Fort Bidwell.

Apocope vulnerata Cope.
Apocope ventricosa Cope.

III. Warner's Lake.

Apocope vulnerata Cope.
Myloleucus formosus Gird.
Catostomus tahoensis G. & J.

IV. Goose Lake.

Myloleucus parovanus Cope.
Myloleucus thalassinus Cope.
Catostomus labiatus Ayres.

V. Klamath Lake.

Salmo purpuratus Pall.
Salvelinus malma Walb.
Myloleucus parovanus Cope.
Squalius cœruleus Gird.
Squalius bicolor Gird.
Chasmistes brevirostris Cope.
Chasmistes luxatus Cope.
Catostomus labiatus Ayres.
Uranidea minuta Pall.

VI. Silver Lake.

Salmo purpuratus Pall. *Myloleucus formosus* Gird.

VII. Abert's Lake.

Salmo purpuratus Pall. *Myloleucus formosus* Gird.
Apocope vulnerata Cope.

VIII. Weber River, Utah.

Rhinichthys transmontanus Cope. *Squalius montanus* Cope.
Agosia novemradiata Cope. *Pantosteus platyrhynchus* Cope.

IX. Fossil Lake, Oregon. (Fossil.)

Leucus altarcus Cope. *Catostomus labiatus* Ayres.
Myloleucus gibbarcus Cope. *Catostomus batrachops* Cope.
Cliola angustarca Cope.

Examination of the preceding lists discloses the following facts: (1). The species of *Leucus* replace in Pyramid Lake the *Myloleucus* of the other lakes. (2). All the species of Pyramid Lake are peculiar to it, excepting the *Catostomus tahoensis*, which is found in the third (and probably other) Warner Lakes, one hundred and fifty miles north of it. (3). The *Myloleucus formosus* inhabits the eastern line of lakes—Warner's, Abert's and Silver Lakes; while the *M. parovanus* is confined to the more western lakes, the Goose and Klamath. (4). The distribution of the Catostomi is similar; the *C. tahoensis* being the eastern, in Pyramid and Warner's Lakes, and the *C. labiatus* in the Goose and Klamath Lakes.

The distribution of the other species is not sufficiently known to enable us to draw any conclusions regarding them.

II. The Fauna of the Idaho Lake.

RAIIDÆ.

Raia pentagona Leidy. *Oncobatis pentagonus* Leidy, Proceeds. Phila. Academy, 1870, p. 70.

A species said to have been found in the beds of this deposit. It is referred to a new genus, by Leidy, who, however, does not characterize it.

CYPRINIDÆ.

This family predominates over all others in the number of species and individuals. Typical carnivorous forms (*Squalius*) were not rare, but the greater number of genera are carnivorous with the teeth less (*Leucus*, *Myloleucus*) or more (*Mylocyprinus*)

adapted for crushing hard substances. The food of such species was probably mollusca. There were but few herbivorous forms, and these (*Diastichus* sp.) not typical, but related to the adjacent carnivorous genera. Especial interest attaches to the present distribution of some of the genera. *Diastichus* is the only one which is extinct, so far as known, though its characters approach those of existing genera so nearly, that it may be found at any time in the recent fauna. *Mylocyprinus* has a living species in China. *Leucus* is found in Europe and Asia. *Myloleucus* is American, and is confined to the lakes of the Great Basin and California; two species occurring in Utah and two in Oregon. *Cliola* is found in North America east of the Sierra Nevada. *Squalius* is generally North American and European.

MYLOCYPRINUS, Leidy.

Proceedings Academy Phila., 1870, 70. Cope, Proceeds. Amer. Philos. Society, 1870, 543. *Mylopharyngodon* Peters, Monatsberichte Berlin Academy, 1880, 925.

I am acquainted with three species of this genus; two extinct from Idaho, and one, the *Mylocyprinus æthiops* Basilewsky, (*Mylopharyngodon* Peters) recent, in China. The pharyngeal bones of these species may be distinguished as follows. I know those of the *M. æthiops* from a figure given by Prof. Peters.

I. Teeth commencing near the symphysis; curvature of pharyngeal very abrupt; apex shorter than tooth-row; *M. inflexus.*

II. Teeth commencing at a distance from symphysis, leaving a style; curvature gradual.

Style and apex each shorter than tooth-row; *M. robustus.*

Style and apex each longer than tooth-row; *M. æthiops.*

Mylocyprinus inflexus Cope, sp. nov.

Established on two pharyngeal bones of the left side, one of which indicates a fish of perhaps two pounds weight, and the other one of half the size. Its form is peculiar in the very abrupt curve of the external border, the great abbreviation of the style, and the shortness of the tooth series. The proximal and distal extremities of the bone are connected across the concavity by a thin expansion of the inner border, not seen in *M. robustus.* The first tooth is small, but larger than the corresponding one sometimes seen in *M. robustus*, so that I would be inclined to think it a permanent character, were it not wanting from the smaller specimen.

The second tooth is broadly molar. Two foramina perhaps indicate the position of two teeth of an internal row. The toothless apex of the bone is longer and flatter than in *M. robustus*. The entire bone is flatter than in that species. The first tooth stands on the edge of the symphysis.

Measurements.	M.
Total length on tooth row, ...	·025
Length of base of tooth row, ...	·018
Length of apex, ...	·016
Width at middle, ...	·018

Near Sinker's Creek, Idaho. J. L. Wortman.

Mylocyprinus robustus Leidy. Loc. cit. Report U. S. Geol. Survey Terrs., i, p 262, Pl. XVII, figs, 11–17.

This is the most abundant fish of the Idaho beds, and is represented by a great many pharyngeal bones with teeth, in my collection. These present a great many variations, and I have proposed in a former paper to recognize three species: *M. kingi*, *M. robustus* and *M. longidens*. Study of my material shows that these forms intergrade, and that if they represent distinct species, two others must be admitted. I incline to look upon the differences as due in part to age, and in part as subspecific variations. I tabulate them as follows:

I. Small; style more slender, five teeth in outer row, the upper very small and subprehensile; the lower small, conic.

II. Like the last, but the style stouter.

III. Like I, but only four teeth; the inferior tooth wanting.

IV. Like I, but four teeth; the superior larger and obtuse; *M. longidens.*

V. Larger; four teeth, the last obtuse but much smaller than the others; style stout; *M. robustus.*

VI. Larger; style stout; four teeth, the superior nearly as large as the others, which are equal; *M. kingi.*

The slenderness or stoutness of style is not coincident with the other characters, but the latter condition is always found in large specimens. In these the convex border is also much thickened. The small, partly hooked form of the superior tooth is only found in small fishes, and is probably a character of youth. It indicates that the genus is descended from more purely carnivorous types.

The minute first tooth is generally found in small specimens, but not always. It lingers in some to middle size. This species has not been found in the Oregon basin. The settlers call the pharyngeal bones "baby-jaws."

LEUCUS Heckel.

Fische Syriens, 1843, p. 48. *Anchybopsis* Cope, Proceed. Amer. Philos. Soc., 1870, p. 543.

Leucus latus Cope. *Anchybopsis latus* Cope, l. c.

Much the largest species of the genus, as yet only represented by two pharyngeal bones of opposite sides. Southern Idaho.

Leucus condonianus Cope, sp. nov.

This fish is represented by four pharyngeal bones, two of each side, which have the dental formula 2·5–5·2; the presence of the two inner teeth being doubtful on one of those of the right side. They indicate a smaller fish than the *L. altarcus*, and one about the size of the *Ceratichthys biguttatus*. The teeth display but little grinding surface, and have swollen subconic crowns, which are less expanded transversely than those of the *L. altarcus*. The style is moderately long and not much recurved. The external aliform border is rather full, and expands gradually from the style, not abruptly, as in *L. altarcus*. It is especially full opposite the superior extremity of the tooth series, where it is contracted in *L. latus*.

Measurements of Medium Size.	M.
Length on tooth line, ...	·014
Length of tooth line, ...	·007
Length of apex from tooth line, ...	·005
Width at middle, ...	·005

Dedicated to Professor Thos. Condon, of Eugene, Oregon, who first discovered and explored in part, the fossiliferous formations of the Oregon and Idaho basins.

SQUALIUS Bonap.

Jordan emend. *Ptychochilus* Agass. *Clinostomus* Girard. *Oligobelus* Cope, Proceeds. Amer. Philosoph. Soc., 1870, p. 540.

The American species generally differ from the type in the reduced number of teeth in the right pharyngeal series. The dental formula is 2·5–4·2, in our extinct and recent species. In the pliocene species here noticed, the teeth have acute, slightly incurved, apices. They differ from each other as follows:

I. Inner face just above superior tooth much narrower than anterior or posterior faces.

a. An external marginal expansion.

Width at fourth tooth equal length of bases of superior three teeth; an external bevel below first tooth; large; *S. posticus.*

Width at fourth tooth considerably less than length of bases of superior three teeth; a bevel below base of first tooth causing ala to be more distinct; large; *S. laminatus.*

Ala not projecting; width less than length of bases of superior three teeth; no bevel below first tooth; smaller; *S. reddingi.*

aa. No external ala.

Bone very narrow; teeth spaced; larger; *S. bairdi.*

II. Inner face just above superior tooth deep, equaling anterior and posterior faces.

No external ala; bone narrow; *S. arciferus.*

Squalius posticus Cope. *Semotilus posticus* Cope, Proceeds. Amer. Philos. Society, 1870, p. 541.

The original specimen is from Idaho. Only a fragment of two others are known.

Squalius laminatus Cope. *Oligobelus laminatus* Cope, loc., cit., 1870, p. 541.

Originally founded on a single fragmentary pharyngeal bone. A complete right-hand bone with all the teeth, found by Mr. Wortman, shows that this is as large a species as the *G. postica*, but of more slender proportions.

Squalius reddingi Cope, sp. nov.

This species is founded on pharyngeal bones of individuals of smaller size than those which represent the others mentioned in this list. They represent a fish of the average dimensions of the *Pogonichthys inæquilobus* of California. The five teeth occupy as much length as the style, and the apex is as long as the bases of four teeth and an interspace. The apex is flat, and its inner face is convex, and as deep at the base as one-half the width. The external alar expansion is slight but distinct, and originates opposite the third tooth from below. The style is not recurved.

Measurements.	M.
Length on tooth series, ...	·026
Length of tooth series, ...	·012
Length of apex from teeth, ...	·011
Width of bone at middle, ...	·005

One right and two left pharyngeal bones of this species were found by Mr. Wortman in Southern Idaho. It is named for my friend, the late Mr. B. B. Redding of San Francisco, Vice-President of the California Academy of Sciences.

Squalius bairdi Cope. *Semotilus bairdi* Cope, loc. cit., p. 542.

This species was established on a right pharyngeal bone which supported four teeth in the principal row. My original reference of it to the genus *Semotilus*, was based on supposition that the left pharyngeal bone would be found to support five teeth in the principal row. This is shown to be the case by such a bone discovered by Mr. Wortman. It belonged to a smaller individual than the typical one, and shows the very narrow basis of a probably shorter style than those seen in the other species here mentioned.

Squalius arciferus Cope. *Oligobelus arciferus* Cope, loc. cit., p. 541.

The most robust species, represented by parts of two pharyngeal bones.

DIASTICHUS Cope.

Proceedings Amer. Philos. Society, 1870, p. 539.

An entire pharyngeal bone of the typical species of this genus has five teeth in a single series. The opposite bone of another species presents also five teeth, so that the formula is probably 5–5. The teeth are compressed and short, and somewhat expanded transversely to the direction of the bone. They display an oblique grinding surface on use. They might then be referred to the genus *Leucus*, but the apical branch of the bone is much more elongate and is truncate at the extremity. This character is best seen in *D. macrodon*, where there appears to have been a superior as well as an inferior symphysis. The direction of the tooth series is at right-angles to this apical portion, as in other genera.

Diastichus macrodon Cope. Loc. cit., p. 539.

A specimen of pharyngeal bone, found by M. Wortman, is not more than half the linear dimensions of those obtained by Mr. King from the same part of Idaho.

Diastichus parvidens Cope. Loc. cit., p. 540.

No additional material.

Diastichus strangulatus sp. nov.

Represented by two pharyngeal bones from Southern Idaho.

One of these lacks the style, and the other the apical portion. The species differs from the *D. macrodon* in the flatter apical ramus, which is devoid of the marginal tuberosity and distal recurvature, seen in that species. It is straight and forms an acute angle with the axis of the tooth series. The style is short, stout, and somewhat recurved. The marginal ala is rather abruptly given off opposite the second tooth from below. The necks of the pharyngeal teeth are contracted, so that the internal and external outlines of the crown are convex. The grinding surface is quite oblique.

Measurements.	M.
Length of tooth line,	·014
Length of apical ramus,	·013
Width of bone at middle,	·010
Width of crown of tooth,	·005

This species was about the size of the gold-fish. From Southern Idaho, J. L. Wortman.

CATOSTOMIDÆ.

Catostomus shoshonensis sp. nov.

Of this fish I have two crania from the Idaho basin, one obtained by Mr. Wortman and the other by Mr. Clarence King. Two other crania, collected by the same gentlemen, represent a variety, or possibly another species.

The bones of the skull are relatively more elongate than those of the *C. labiatus*. The width of the superior surface of the parietal bones between the lateral angles is equal to two-thirds the length of the superior surface of the ethmoid bone posterior to the base of its anterior spine. The two measurements are equal in the *C. labiatus*. The ethmoid has three median longitudinal concavities and raised borders in the *C. shoshonensis*, but is regularly convex in the *C. labiatus*. The temporal fossa is separated by a narrow raised band from the pterotic fossa in the former, but by a very wide band in the latter. The supratemporal crests are not raised and sink gradually to the level opposite the posterior part of the supraorbital border. There is a slight median frontal keel which extends forwards from the same point. The frontoparietal fontanelle is well defined, elongate, and rather narrow. It commences at the base of the supraoccipital spine and extends to opposite the anterior foramen of the postfrontal bone. The bones of the skull are smooth.

Measurements.	M.
Length from apex of epiotic to end of ethmoid spine, inclusive,	·075
Length of ethmoid without spine (median),	·018
Length of frontal bone (median),	·030
Length of parietal (median),	·0105
Interorbital width,	·028
Width at pterotics,	·040
Width between apices of epiotics,	·0245
Width of parasphenoid at middle of orbits,	·0070
Diameter (long) of hyomandibular cotylus of pterotic,	·0070.

The above measurements equal those of the largest size of the *Catostomus teres* of our waters. It will be desirable to compare its skull with that of *C. macrochilus* Gird., which comes from the Columbia River. Girard says that it is of more elongate proportions than that of the *C. labiatus*.

Catostomus cristatus sp. nov.

This species is known to me from a skull, of which only the cranium posterior to the anterior orbital region remains. It belongs to the same elongate type as the *C. reddingi*, and differs from that species as follows:—

The lateral casts of the frontal bone are more elevated, and are carried farther forwards. Instead of gradually disappearing anteriorly, they descend abruptly to their termination, enclosing a groove with the supraorbital plate of the frontal. The fontanelle is wide, and extends farther into the frontal bone. The low median frontal ridge commences at its anterior border. The bridge between the temporal and pterotic fossæ is narrow. There is a transverse ridge on each half of the supraoccipital bone; in *C. reddingi* this ridge is oblique, descending towards the middle line.

Measurements.	M.
Length of parietal bone (median),	·014
Length of frontoparietal fontanelle,	·023
Width at pterotics,	·046
Width between frontal crests at anterior extremities,	·014
Width between apices of epiotics,	·024
Diameter (long) of hyomandibular cotylus,	·008

Found by J. L. Wortman in S. W. Idaho. One specimen only.

COBITIDÆ.

A species of this family left remains in the Idaho Lake basin. I have reached this conclusion by the discovery, among the specimens submitted to me by the Smithsonian Institution, of the inferior element of the three modified anterior vertebræ,[1] which are so characteristic of certain families of the Physostomous fishes. This portion, moreover, is that which occupies the position among the Cobitidæ only. Among them, it consists of a longitudinal plate terminating posteriorly in a bladder-like chamber on each side, each of which is closed below by a transverse process of the inferior plate; an angular fissure extends around the ends of these, and at the angle sends a short continuation upwards. This is quite similar to what is observed in *Cobitis*.

This occurrence of *Cobitidæ* is, perhaps, the most interesting fact brought to light by the examination of these extinct fishes. All of the numerous existing species of this family are found in the Eastern Hemisphere, and the great majority in tropical Asia, a few only occurring in Europe and South Africa. Extinct species are found in the miocene of Oeningen. We have then, in this form, another example of the occurrence of Asiatic types in North America prior to the glacial epoch; and as in a fresh-water fish, more strongly demonstrative of continuity of territory of the two continents, than can be with any other type of animal.

SALMONIDÆ.

RHABDOFARIO Cope.

Proceeds. Amer. Philosoph. Society, Nov., 1870.

A genus represented by skulls, in which the maxillary bone is cylindrical and rod-like, thus differing from *Salmo*.

Rhabdofario lacustris Cope, l. c.

A species with a head as large as that of the *Salmo salar*, which was not uncommon in the Idaho Lake. In addition to the type obtained by Mr. King, Mr. Wortman found parts of several individuals.

SILURIDÆ.

AMIURUS Raf.

? Amiurus sp.

Represented by pectoral spines. These do not differ from those of some recent species, but differ from those of the species of

[1] The pharyngeal bones referred to this family by me as above cited, belong to the Cyprinidæ in the restricted sense. See genus *Diastichus*.

Rhineastes from our eocene beds, except perhaps the *R. arcuatus*, in the possession of but one row of teeth. The surface is delicately striate. The anterior edge is smooth and acute, and the posterior edge has two rows of serræ separated by the usual groove.

COTTIDÆ.

COTTUS L.

I refer to this genus four species from the Idaho beds. They may belong to *Uranidea*, but as I can only identify them as yet by the preopercula, I cannot determine this point. The parts in question are not rare, showing that this type was well represented in this region.

The preopercular bones are furnished with three or four acute spines of no great length. In this they differ from the living American species of *Uranidea*, which have only one or two spines, excepting the *U. spilota*, which has (*fide* Jordan) four spines, three of which are inferior. The four species of the present collection differ in their prominent features, as follows:—

a. Foramina on inner side of preoperculum.

Four spines; angular spine directed backwards; inferior ones forwards; smaller; *C. divaricatus.*

Angular spine directed backwards; posterior inferior downwards; inner side with two faces separated by an angle; larger; *C. pontifex.*

aa. Foramina on the posterior edge of preopercle.

Angular spine directed backwards; two strong similar inferior spines turned forwards; larger; *C. cryptotremus.*

aaa. No foramina.

Angular spine directed downwards; inferior spines forwards; the anterior inferior flattened; large; *C. hypoceras.*

Cottus divaricatus sp. nov.

Represented by two preopercula. These indicate the smallest of the four species, and one about equal to the *C. richardsoni*, Ag. The preoperculum is flatter and thinner than in the other species, and the foramina are all on the inner side of the branches. These are: one large one above base of superior spine, one small one between bases of superior and angular spines, one do. between bases of angular and posterior inferior, and one at anterior base of posterior inferior. The two inferior spines are smaller than the others, and are incurved. The superior posterior is the largest

and is curved upwards, and compressed at the base. Both external and internal faces are flat.

Measurements.	M.
Length from base of superior to base of exterior inferior spines, inclusive, ...	·008
Length of superior spine above, ...	·003

From Willow Creek, Oregon. J. L. Wortman.

Cottus pontifex sp. nov.

The preopercular bone of this species is robust, especially in the transverse diameter. Instead of being flat as in *C. divaricatus*, it presents two faces on the side which is perforated by foramina, which are separated by a vertical angle. The anteroexterior face is flat, while the posteroexternal is somewhat irregular. The foramina which pierce it are larger than in any other species, especially the one between the second and third spines. The foramina communicate below the surface, the canal thus formed being spanned by a narrow bridge from the base of each spine. The opposite side of the preoperculum is a little concave, and plane at the base of the spines. The bases of the superior and the angular spines are closer together than in any other species, being absolutely in contact.

Measurements.	M.
Length of three upper spines on bases, incl., .	·008
Length of joined bases of two upper spines, .	·005

It is not possible to be certain whether there is any anterior inferior spine. One specimen was obtained by Mr. Wortman, probably from Willow Creek, Oregon.

Cottus cryptotremus sp. nov.

A larger species, very different from the last, and nearer the *C. divaricatus*. Three preopercula are in my collection. In all the specimens the superior limb is broken off, so that it is impossible to state the character of the superior spine. The angular spine has a round section and is directed backwards, and in line with the inferior border. The two inferior spines are at a little distance from its base, and are well developed, acute, and of equal size. They are directed forwards and inwards. The external face of the inferior limb is divided by a prominent obtuse angle on its entire length. There is a small foramen at the posterior

base of each inferior spine, and a large one at the anterior extremity of the inferior branch, looking partially outwards.

Measurements.	M.
Length of base of three inferior spines, incl.,	·0085
Length of inferior spines, inclusive,	·0055
Length of anterior inferior spines,	·0045
Length of inferior branch of bone,	·0140

Discovered by Mr. J. L. Wortman, Castle Creek, Idaho.

Cottus hypoceras sp. nov.

The preoperculum of this species differs widely from those of the three already described. Although it has four spines, they are distributed differently, three being inferior and one posterior, instead of two posterior and two inferior. The base of the posterior spine is less compressed than in the others, and looks as though the apex is directed posteriorly instead of superiorly as in *C. divaricatus*, and *C. pontifex*. It is opposite the inferior branch instead of above it as in the species named. The angular spine is round at the base; the first inferior is compressed at the base, and the anterior is compressed to the rounded apex, its superior edge being acute, the inferior rounded. This spine therefore differs from that of any of the other species.

The external face is gently rounded, and is smooth. The internal face has the usual excavation with bordering rim, and is roughened. There are no foramina except two above the base of the anterior inferior spine. In size this species is about like the *C. pontifex*.

Measurements.	M.
Length of base of four spines, inclusive, in a straight line,	·011
Length of bases of anterior two inferior spines inclusive,	·007
Length of angular spine,	·004
Elevation of vertical limb of preoperculum,	·012

One specimen; obtained by Mr. J. L. Wortman, probably at Willow Creek, Oregon.

PERCIDÆ.

The spines of the dorsal fin of a species of this family are not rare in the formation, but I have not yet been able to fix them generically or specifically.

General Observations.

In the preceding pages there are described from the Idaho pliocene formation the following species :—

Percidæ,	1	species.
Cottidæ,	4	"
Salmonidæ,	1	"
Cyprinidæ,	11	"
Catostomidæ,	2	"
Cobitidæ.	1	"
Siluridæ,	1	"
Raiidæ,	1	"
Total,	22	species.

Of the above, all differ from existing species so far as known, but three of the species which represent the *Percidæ*, the *Cobitidæ* and the *Siluridæ* respectively, have not been exactly determined. All the species differ from those of the Oregon Lake (or Lake Lahontan as it may prove to be). Of the families, all are existing and all are represented on the North American Continent excepting the *Cobitidæ*, which are now confined to Eur-Asia. But of these eight families four are not now found in the American waters which empty into the Pacific Ocean, viz., the *Percidæ*, *Siluridæ*, *Cobitidæ*, and *Raiidæ*, excepting that there is one species of the Percidæ in California. Five of the seven families have not yet been found in the Oregon fossil lake basin, but as two of them (*Salmonidæ*, *Cottidæ*), are found in the existing lakes of that region, they will probably be found in that deposit.

The above evidence is sufficient to prove that the Idaho pliocene formation is distinct from any formation previously known. It is older than the Oregon lake deposit.

In addition to the fishes, three species of craw-fishes were discovered in this formation by Capt. Clarence King. These I named *Astacus subgrundialis*, *A. chenoderma*, and *A. breviforceps*.[1] The mollusks of this formation have been described by F. B. Meek, and they, like the fishes, determined it to be lacustrine and fresh, as already stated by Prof. Newberry. The species are stated by Meek[2] to be distinct specifically, and in some cases

[1] Proceedings Amer. Philos. Society, 1870, p. 605. Loc. cit., Nov. 1870.
[2] Proceedings Acad. Nat. Sci., Phila., 1870, 56.

generically, from all others hitherto described from the West. Leidy observes,[1] that mammalian remains received from Capt. King's expedition include portions of *Mastodon* and *Equus excelsus*. Mr. Wortman obtained teeth and bones of the latter, and a cannon-bone of an undetermined ruminant of the size of the *Cervus elaphus*. The ungual phalange of an edentate allied to *Megalonyx* was obtained from the same horizon and locality.

The map of the adjacent parts of Oregon, Nevada and California, showing the lakes, is copied from the map issued by the War Department of the United States, Brig. Gen. A. A. Humphreys, Chief of Engineers.

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[1] L. c., 1870, 67. On Cretaceous and Tertiary Reptilia and Fishes, by Prof. E. D. Cope, November, 1870.